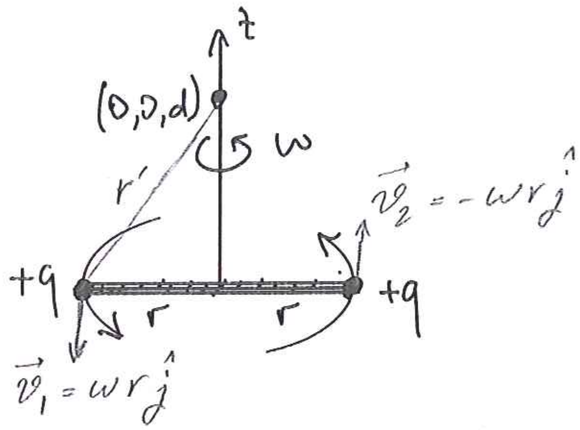
PHYS 102: General Physics - KOÇ UNIVERSITY
College of Sciences
Quiz 8 Dec 2, 2016

Closed book. No calculators are to be used for this quiz.
Quiz duration: 10 minutes
Name: ID #: Signature:

Q. Two small masses with charge $+q$ each are attached to the ends of a neutral bar with length $2r$. The bar rotates at fixed angular speed ω around the z-axis with its center fixed at the origin. Calculate the magnetic field magnitude at point $(0, 0, d)$ on the z-axis.



$$\vec{B} = \frac{\mu_0}{4\pi} \frac{q \vec{v} \times \hat{r}'}{r'^2}$$

$$\begin{cases} \vec{r}_1' = -r\hat{i} + d\hat{k} \\ \vec{r}_2' = r\hat{i} + d\hat{k} \end{cases}$$

$$r' = \sqrt{r^2 + d^2}$$

$$\Rightarrow \vec{B} = \frac{\mu_0}{4\pi} \frac{q}{r^2+d^2} \left(\vec{v}_1 \times \hat{r}_1' + \vec{v}_2 \times \hat{r}_2' \right)$$

$$\Rightarrow \vec{B} = \frac{\mu_0}{2\pi} \cdot \frac{q \omega r^2}{r^2+d^2}$$

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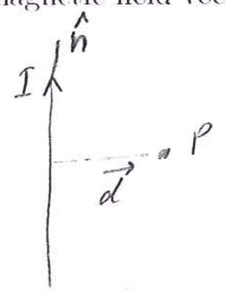
Q. A wire laying on the x-axis is carrying a current I. What is the magnetic field vector at the point (x, y, z)?

we know: $\vec{B} = \frac{\mu_0 I}{2\pi} \frac{\hat{n} \times \hat{d}}{d^2}$



In this problem: $\hat{n} = \hat{i}$, $\hat{d} = y\hat{j} + z\hat{k}$

$$\Rightarrow \vec{B} = \frac{\mu_0 I}{2\pi} \frac{1}{y^2+z^2} \left[\hat{i} \times (y\hat{j} + z\hat{k}) \right]$$

$$\Rightarrow \vec{B} = \frac{\mu_0 I}{2\pi (y^2+z^2)} (y\hat{k} - z\hat{j})$$

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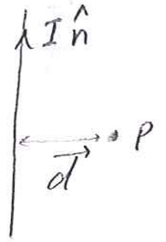
Q. A very long wire carrying a current I lays parallel to the x-axis, intersecting the y-axis at $(0, -a, 0)$. Find the magnetic field vector at the point $(0, 0, z)$ on the z-axis.

we know:

$$\vec{B} = \frac{\mu_0 I}{2\pi} \frac{\hat{n} \times \hat{d}}{d^2}$$



In this Question: $\hat{n} = \hat{i}$, $\hat{d} = a\hat{j} + z\hat{k}$

$$\Rightarrow \vec{B} = \frac{\mu_0 I}{2\pi} \frac{1}{a^2+z^2} \left[\hat{i} \times (a\hat{j} + z\hat{k})\right]$$

$$\Rightarrow \vec{B} = \frac{\mu_0 I}{2\pi(a^2+z^2)} (a\hat{k} - z\hat{j})$$

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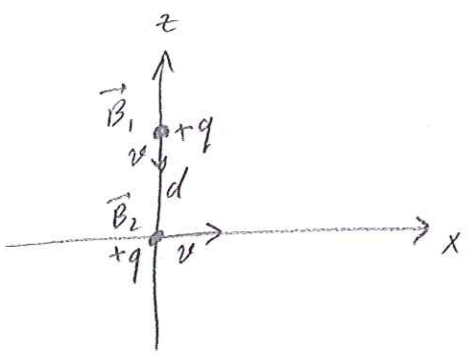
Q. A point charge $+q$ located at $(0,0,0)$ is moving in $+x$ direction with speed v. A second, identical charge at $(0,0,d)$ is moving in $-z$ direction (towards the first charge) with the same speed. Calculate the magnetic force on each particle separately. According to your answer, is Newton's 3rd law satisfied?



$$\begin{cases} \vec{B} = \dfrac{\mu_0}{4\pi} \dfrac{q\,\vec{v} \times \hat{r}}{r^2} \\ \vec{F} = q\,\vec{v} \times \vec{B} \end{cases}$$

$$\begin{cases} \vec{B}_1 = \dfrac{\mu_0}{4\pi} \dfrac{q}{d^2} (v\hat{i} \times d\hat{k}) = \dfrac{\mu_0}{4\pi} \dfrac{qv}{d} (-\hat{j}) \\ \vec{B}_2 = \dfrac{\mu_0}{4\pi} \dfrac{q}{d^2} (-v\hat{k} \times (-d)\hat{k}) = 0 \end{cases}$$

$$\Rightarrow \begin{cases} \vec{F}_{1\to 2} = 0 \\ \vec{F}_{2\to 1} = q(-v\hat{k} \times \vec{B}_1) = \dfrac{\mu_0}{4\pi} \dfrac{q^2 v^2}{d} (-\hat{i}) \end{cases}$$

$$\Rightarrow \vec{F}_{1\to 2} \neq -\vec{F}_{2\to 1}$$

Newton's 3rd law doesn't statisfied